# University of Cincinnati

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**I, Lauren Novelli , hereby submit this original work as part of the requirements for the degree of Master of Public Health in Health Services Management.**

It is entitled:

**Racism and Infant Mortality: Links Between Racial Stress and Adverse Birth Outcomes for African American Women and their Infants**

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**Committee chair: Mary Beth Genter, Ph.D.**

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# Racism and Infant Mortality: Links Between Racial Stress and Adverse Birth Outcomes for African American Women and their Infants

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B.A., English

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## Abstract

Background: There is a widening health gap in birth outcomes for Black women and white women in America. Historically this gap has been relegated to disparities regarding other social factors such as; socioeconomic status, geographic location, and education level. However, these factors prove to only be partially responsible for the gap in birth outcomes between Black women and white women. Improved understanding of the burden of racial stress that Black women undergo throughout their lifetimes provides a better foundation for improving health outcomes, specifically birth outcomes for Black women.

Objectives: Secondary data analysis is utilized on National Vital Statistics System data from 2002-2012 to determine if there is a link between adverse birth outcomes and race, despite similar education levels and prenatal care visits between non-Hispanic Black women and non-Hispanic white women.

Methods: Using retrospective birth data from the National Vital Statistics System from 2002-2012, five variables were analyzed. These variables; maternal education attainment, number of prenatal care visits, preterm birth, low birthweight, and very low birthweight showcase different birth factors. By using aggregate data for non-Hispanic Black women, and non-Hispanic white women for each factor in each year, the percentage was then calculated. Following the calculation of averages, the statistical t-test was run to determine the p-values for each factor to determine statistical significance. Additionally, the total number of births for non-Hispanic Black women and non-Hispanic white women was recorded to showcase the difference in total birth rates for the aforementioned races.

Results: The data from 2002-2012 showed a significant widening in health outcomes for Black and white women. There was no statistical significant difference for educational attainment between the races with a p-value of: 0.08163186. A significance was found between the rates of prenatal care visits between the races with a p-value of: 0.00015265. Statistical significance was found between the rates of preterm birth and low birthweight, and very low birthweight between Black and white women with p-values of <.00001 for all three outcomes.

Conclusions: Further analysis regarding the possible role of racism and adverse health outcomes needs to be implemented to better understand the widening health gap between Black and white Americans. The impact of adverse birth outcomes for Black women is significant, and should be addressed by future models of public health programming to improve infant mortality rates as well as health disparities that exist later in life for Black Americans.


*Keywords:* Infant Mortality, Preterm birth, Low birthweight, Very low birthweight, racism

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## Introduction

Infant mortality has been a concern of public health professionals since the early 1900s when the US Children's Bureau was founded in 1912 to combat rising infant deaths. (Brosco 1999). Infant deaths resulted from unsanitary labor conditions as well as infants' and mothers' lack of access to clean living conditions. The Centers for Disease Control (CDC) defines infant mortality as the death of an infant before its first birthday. Infant mortality is often the result of an adverse birth outcome during pregnancy or birth. I define accompanying adverse birth outcomes in this project as; preterm birth, low birthweight, and very low birthweight. All adverse birth outcomes suggest a need for public health intervention.

Today, public health professionals execute infant mortality prevention efforts by implementing programming aimed at improving maternal knowledge regarding a "proper" pregnancy. The purpose of these programs is aimed at reducing mothers' and infants' exposure to external toxicities such as secondhand smoke and alcohol. In Cincinnati, the maternal and infant health initiative, Cradle Cincinnati, has implemented a similar program called: "3S". This program encourages pregnant women to enhance spacing between pregnancies, quit smoking, and utilize safe sleep practices for their infants. Federal examples of public health programs involving pregnancy care include state-funded prenatal education and the supplemental nutritional program, Women, Infants, and Children (WIC).

Prenatal programs exclusively target pregnant women because US society views women as bearing all of the responsibility for the birth of a healthy child (Wetterberg 2004). As a feminist, I critique this neoliberal approach to reducing infant mortality and instead propose a public health intervention that recognizes social determinants of health. Social determinants of

health include, but are not limited to,; socioeconomic status (SES), race, education level, geographic location, and age (WHO). Public health studies, such as Dressler, Oths, and Gravlee's' (2005) study and Hogue and Hargraves' (1993) study, illustrate that social determinants of health outside of the individual mothers' control can lead to infant mortality.

Race as a social determinant of health is a key point for prenatal public health intervention. As of 2009, the infant mortality rate (IMR) for non-Hispanic Black women is 12.8 per 1,000 live births, while the IMR for non-Hispanic whites is 5.5 per 1,000 live births (CDC). Additionally, the racial stratification of infant mortality rates is cause for concern, because the IMR for Black women does not improve with education or socioeconomic status (Schoendorf, Hogue, Kleinman, and Rowley 1992), further disproving the protective prenatal education public health ideology.

In my project, I seek to demonstrate that Black women experience higher rates of adverse birth outcomes than white women due to the allostatic load of external and internal racism. Allostatic load refers to the physiological effects of stress over an extended period of time (McEwen 2006). I aim to examine the relationship between racism and adverse birth outcomes by comparing adverse birth outcome rates by race, education level, and number of prenatal care visits. By examining the similar levels of maternal educational attainment, and prenatal care visits, I will be able to demonstrate if an association between race and adverse birth outcomes exists despite similar education and prenatal care levels.

My project will use feminist science to analyze the relationship between adverse birth outcomes and racism. Feminist science expands upon traditional uses of scientific research to include gender, race, and class as quantifiable aims of study (Harding 1986). Feminist science responds to a need for epistemic knowledge that legitimizes social constructs. Feminist science

bridges the biological framework with the feminist framework to create a complete understanding of a scientific issue. Further, feminist science critiques and analyzes gaps in research beyond the traditional scientific lens. Feminist science in this project constitutes an interdisciplinary approach, as I will use public health studies to demonstrate the statistical trends in adverse birth outcomes by race, and feminist theory to analyze how Black bodies are co-opted by medicine and science.

I have analyzed a decade of adverse birth outcomes [2002-2012 (preterm birth, low birth weight, and very low birthweight)] records from the CDC's reporting system, the National Vital Statistics System. I analyzed only data of non-Hispanic white women, and non-Hispanic Black women. These data illustrated a long-standing trend in the United States of racial stratification between birth outcomes of Black and white women. Additionally, I analyzed the levels of educational attainment and prenatal care visits of the mothers to further dispel the notion that low educational attainment and prenatal care visits contribute to adverse birth outcomes of Black women. These data are not as readily available due to changes in reporting standards by the National Vital Statistics System. Further, because all of these data are self-reported, there could be discrepancies between what is reported by the mothers, and the actual rate.

Following the analysis of race and birth outcomes, I will argue that scientists should consider racism as a quantifiable exposure. The majority of scientists do not accept racism as a quantifiable scientific exposure because currently there is no clear medical or scientific method to assess or measure racism. In all scientific and medical studies, the exposure is clearly measured in order to determine if an association exists between an exposure and outcome. I will argue that racism is measurable through the use of questionnaires regarding racism and accompanying stress. I will use retrospective scientific studies (previously completed studies)

from a range of public health and medical journals that used questionnaires, to gauge racial stress of individuals to support my claim. It is important to recognize that questionnaires can prove to be problematic as they are often confounded by recall bias, or a lack of accuracy in the participant's memory. However, questionnaires are considered an acceptable option as researchers use questionnaires for a variety of non-measurable epidemiological exposures including stress and emotions.

Finally, I will incorporate feminist theory and scholarship to further my claim that racism affects birth outcomes for Black women. I will apply Michel Foucault's theory of biopower and Roberts' *Killing the Black Bod*y to prove that Black women are subjugated by the medical institution. These texts provide a useful framework for deconstructing how bodies (specifically marginalized bodies) become negotiated and controlled through the state

## Literature Review

In this chapter I will describe the foundation for my project with previously published pertinent literature. This section will include retrospective data studies, as well as feminist texts. It will describe the existing research that is available regarding Black women and their adverse health status.

According to most public health experts, educating pregnant women about proper prenatal care will prevent adverse birth outcomes (Karlsen, Say, Souza, Hogue, Calles, Gulmezoglu, Raine 2011). This ideology has become a core belief of public health since Steven Gortmaker's (1978) study examining the relationship between prenatal care and adverse birth outcomes in New York City in 1968. The most notable interpretation of this study's findings was the claim that prenatal care reduced the risk of adverse birth outcomes for both white and Black mothers, resulting in a colorblind approach to prenatal care that still exists today. Gortmaker's

colorblind approach is an example of colorblind racism in public health, or the belief that persons of different racial backgrounds experience no social structural differences in opportunities or constraints (Ford and Airhihenbuwa 2010). Gortmaker's research did not incorporate social constructs of race or racism, but instead instituted a neoliberal ideology theorizing that the mother is responsible for the health of her fetus and infant. As a result of Gortmaker's published findings, public health programming has emphasized the individual mother's responsibility for the fetus' health, based on Gortmaker's assumption that there is no racial difference in women's ability to access and receive prenatal care. This theory does not acknowledge health factors that individuals cannot control such as access to nutritious foods and lack of medical insurance, and thus increases the guilt and shame of Black mothers when their infants experience adverse birth outcomes (Perry 2011). Further, this ideology fails to educate Black women about adverse birth outcomes despite receiving prenatal care.

*Black Reproduction*

The United States has systematically controlled and denigrated Black women's reproduction since the 1800s. Dorothy Roberts' (1995) book, *Killing the Black Body*, traces the social control over Black reproduction from the institution of slavery to the continued contemporary racial stratification of reproduction. In the present, racial stratification exists in reproduction through the disparity between birth outcomes for white and Black mothers. Black mothers continue to see higher rates of infant mortality, preterm birth, low birthweight (LBW), and very low birthweight (VLBW), despite similar socioeconomic and education statuses (Schoendorf, Hogue, Kleinman, and Rowley 1992). Further, this disparity exists despite the

similar number of prenatal care visits both sets of women received, suggesting a need for further analysis regarding reproductive racial stratification.

Reproductive racial stratification has roots in the eugenics movement, as Black women were sterilized at higher rates than white women to reduce Black births (Roberts 1995). Contemporarily, Black women have stated that even when they receive prenatal care, the medical institution is disinterested in their narrative sand medical needs (Bridges 2011). The lack of attention towards Black mothers through the medical institution reflects the deeply entrenched racism in medical institutions (McDaniel 1996). Further, it is representative of the problematic current racial ideology in the United States that touts a post-racial ideal. Post-racial ideology is the ideology that racism is no longer an issue in the United States. This ideology has become particularly pronounced following the 2008 presidential election of Barack Obama. (Lee 2011). A post-racial ideology would only recognize the similar rates of prenatal care between Black and white women and fail to recognize the lack of autonomy Black women are afforded in medical institutions.

*Pregnant Black Women and Prenatal Care*

Prenatal care is a non-protective factor for Black women, and also a site of surveillance and medicalization. Black women experience surveillance through the prenatal institution as doctors and public health programmers seek to control their pregnancies and bodies (Bridges 2011). Prenatal care thus creates an oppressive dichotomy for Black pregnant women. If women seek prenatal care, they tacitly accept the surveillance consequences that accompany state-regulated health interventions. However, if Black women do not seek prenatal care, society will

impose the "bad mother" stigma, as they failed to protect the health of the fetus (Wetterberg 2004).

*Biopower*

Similar to neoliberal ideology and colorblind racism, Black pregnant bodies are also marginalized through biopower. Michel Foucault's (1977) theory of biopower proposes that individuals are under constant state surveillance and are often manipulated to comply with state-regulated activities. This poststructuralist theory of surveillance is especially applicable to Black pregnant bodies as they experience more intense scrutiny and surveillance than non-Black bodies. Foucault also extends his theory of biopower to analyze medical institutions. The patriarchal institution of medicine has co-opted reproduction as a means to sustain control over women's bodies and survey their pregnancies. Based on this theory, the medical institution is racially biased and consequently has adverse effects on Black women because they are under surveillance for both their race and gender.

*Black Sexuality*

One proposed theory pertaining to Black women and their status as hyper-surveyed is a result of propaganda surrounding Black women's sexualities. Black women's sexualities are a site of racial stratification because Black women are believed to be hypersexual (Perry 2011). The belief that Black women are hypersexual is amplified when Black women are pregnant, as populations can visually see that a Black woman has had sexual intercourse to become pregnant (Ludtke 1997). Black women also experience hyper-surveillance through the male gaze. Bell hooks (1992) addresses the consequences of the white gaze on the Black body. As of 2014, 66%

of all physicians are male (Kaiser Family Foundation) therefore it is likely that pregnant Black women will be under the scrutiny of male physicians. The gaze of white men onto Black bodies not only deepens stereotypes but also leads to a racial internalization by Black women. Hyper-surveillance of bodies is a type of racism and thus could lead to increased levels of stress in pregnant women.

## Link Between Racism and Adverse Birth Outcomes

In this section I will examine several key scientific papers and studies that explicate the ways in which racism is linked to adverse birth outcomes. These studies span decades, as well as disciplines. Because racism is impossible to measure empirically, these studies create an outline for possible alternatives in measuring racism. Future scientific studies can adapt these approaches to incorporate self-discrimination as a measure for epidemiological studies.

Collins, David, Handler, Wall, and Andes (2004) conducted one of the first epidemiological case-control studies investigating racism as a risk factor for low birthweight. Based on data collected in Chicago between 1997-2000, the authors found a link between maternal exposure to racism and infants born with very low birthweight (VLBW). This study defined infant VLBW as an infant weighing less than 1500g, whereas a non-VLBW infant weighed over 2500g. An association between maternal exposure to racism and VLBW was determined following the completion of racial discrimination questionnaires by case and control participants. The case participants for this study were 104 Black women who delivered very low birthweight and preterm (<37 weeks) infants. The control participants for this study were 208 Black women who delivered non-low birthweight infants. Black interviewers administered the structured questionnaire which consisted of questions gauging the participant's experience of

racial discrimination in five life domains (work, getting a job, at school, getting medical care, and getting service at a restaurant and / or store). The results showed a significant odds ratio (3.2) between self-reported racism and infant birth weight. Researchers also determined that the association between racism and adverse birth outcomes persisted across maternal demographic, biomedical, and behavioral characteristics, thus dispelling the ideology that high educational attainments reduce the risk of infant mortality and adverse birth outcomes.

Another epidemiological study conducted by Cheryl Giscombe and Marci Lobel (2005) examined the disparity that exists between Black and white infant mortality rates, as well as the resulting life-long consequences for VLBW and preterm infants born to Black mothers. Giscombe and Lobel conducted a meta-analysis of existing epidemiological studies to explore the relationship between race, racism, and adverse birth outcomes. The authors found a direct correlation between race and adverse birth outcomes. However, it is important to note that the authors themselves refuse to use the term race and instead use ethnicity.

> "We avoid the term *race* because of lack of agreement about its definition and about its biological and social underpinnings. Instead, we use the term ethnicity as recommended by psychologists to refer to groups whose physical characteristics affect their identity, their treatment by others, and their position in society"

The authors also found an association between chronic diseases in Black adult populations and low birthweight and preterm infants. These diseases include, but are not limited to,; heart disease, diabetes, and hypertension. These chronic illnesses are disproportionately represented in Black communities. Therefore, adverse birth outcomes are not simply a problem in the first year of life, but throughout an adult's lifespan. Public health professionals should therefore address

the disparities that exist in birth outcomes as it could improve the overall health status for adults as well.

In their study, Giscombe and Lobel delineate between individual racism and structural racism. Individual racism is "experienced personally and involves direct experiences with unfair or biased treatment" whereas structural racism is "embedded in the framework and policies of a formal body or organization". The authors identify institutional racism as the main cause for maternal stress during pregnancy as these women "internalize" these racist practices affecting their ability to mentally protect against harm. The study also outlines how maternal stress produces adverse birth outcomes: VLBW and preterm birth. Three biological pathways lead to adverse birth outcomes and maternal stress: neuroendocrine, vascular, and immune-inflammatory. The neuroendocrine pathway is affected through increased levels of corticotrophin released from the brain, which results in repressed cell growth and a stressed placenta. The authors theorize that this leads to preterm birth as the fetus tries to expel itself from the stressed womb. The vascular pathway is affected through chronic hypertension, which is also a major risk factor for preterm birth. Finally, the immune system is affected by stress, as it becomes less functional leading to higher respiratory infections and VLBW infants.

The Giscombe and Lobel meta-analysis differs from other epidemiological studies about maternal stress as it suggests that there could be biological reasons that stress affects Black women more than white women. In my project, arguing against the ideology that Black women experience adverse birth outcomes due to their biologically based racial differences in stress response will be integral.

In conclusion, Giscombe and Lobel advocate using a multivariate statistical analysis approach in further public health and epidemiological studies regarding adverse birth outcomes, because multiple factors could contribute to adverse birth outcomes. This article, although helpful, requires a critical examination because it is based in social constructionism but also hints of biological racism. By inferring that Black women themselves are prone biologically to stress, the social constructionist argument of stress resulting from Black women's experience of racist discrimination is weakened.

Internalized racism is integral in understanding the relationship between adverse birth outcomes and race. Pyke's (2010) study explores racism and oppression and its subsequent effects on the human body. This sociological study examines the affects on Black Americans and other people of color when they internalize racism. Furthermore, this study examines why only psychologists and not other academics have questioned the psychological effects on internalized racism on people of color. "Like all forms of internalized domination, internalized racism is not the result of some cultural or biological characteristic of the subjugated. Nor is it the consequence of any weakness, ignorance, inferiority, psychological defect, gullibility, or other shortcoming of the oppressed" ,Pyke defines internalized racism as a trauma that people experience daily. Internalized racism is associated with adverse birth outcomes because it increases levels of stress on the individual. Public health discourse, therefore, can not solely acknowledge the mother's responsibility for fetal health. To implement this public health practice is to commit colorblind racism, because race as a confounding factor is not considered.

*Conclusion*

By using these studies as a framework, my research will further the claim that internalized racism results in adverse birth outcomes by suggesting a long-term trend of

continued racial stress resulting in the disparities between birth outcomes of Black and white mothers. Further, my research will suggest a scientific need to create a standardized approach when "measuring" racism so that further claims about the physiological effects of racial stress can be addressed. This project will fill a gap in existing research that currently only seeks to address issues within social determinants of health and the health gap. My research will fill the current gap in health research by acknowledging factors outside of socioeconomic status that cause poor health status. My research will also address issues regarding maternal education knowledge by refuting the ideology that proper prenatal care is a protective factor for Black women against adverse birth outcomes. The majority of public health and other epidemiological studies have not conducted case studies that examine birth outcomes between Black and white women with the same socioeconomic status or level of maternal education. My research, although not a new study, will fill this gap by examining the birth outcomes of Black and white women as well as examining their level of maternal education and number of prenatal care visits.

**Project Aim: To determine if high rates of adverse birth outcomes for Black women are sustained , despite similar maternal education levels and prenatal care visits as white women with good birth outcomes as a result of internalized racism.**

## Methodology

In this chapter I will describe the data collection source used for my secondary data, as well as the data collection procedures and accompanying risk factors analyzed. I will also describe the measures for the data analysis.

*National Vital Statistics System*

The National Vital Statistics System (NVSS) in the United States is representative of quality information and data sharing between inter-governmental agencies. The National Center for Health Statistics (NCHS), operated through the Centers for Disease Control and Prevention (CDC) is responsible for obtaining primary data and then submitting it to the NVSS. Examples of data that is collected by NCHS include; births, deaths, marriages, divorces, and fetal deaths. These data come from all 50 states in the United States, as well as Washington D.C., New York City, and the 5 territories (Puerto Rico, the Virgin Islands, Guam, America Samoa, and the Commonwealth of the Northern Mariana Islands). These data are available online: http://www.cdc.gov/nchs/nvss/birth_products.htm for public consumption. Data sets can also be requested in printed format.

Standardized forms are used in the collection of NVSS data, to ensure consistency across the years. Further, by using standard forms, trends are more clearly represented because the same factors are being measured from year to year. Although standardized forms have been used continually, some changes over the years to birth data reporting requirements have been implemented. The most prominent of these changes is the opportunity to code multiple race and Hispanic data in categories for the mother and infant.

The data from which this project is embedded include; race of mother, maternal educational attainment, number of prenatal care visits, preterm birth, low birthweight infants (LBW), and very low birthweight infants (VLBW).

*Data Collection*

This study uses pre-existing datasets, which were compiled by the National Vital Statistics System. The University of Cincinnati Institutional Review Board approved this study on March 31, 2014.

Data was analyzed by first gathering the *Births: Final Data* sets from 2002-2012 from the National Vital Statistics System. All of the data gathered from the NVSS is a result of information entered into birth certificates in the United States. Birth certificates are required for all live births in the United States and therefore all births from 2002-2012 are encompassed in these data. These data sets are typically between 100-125 pages and contain several key indicators for pregnancy and birthing health.

Individuals are included in this data if they gave birth in all states and DC, as well as Puerto Rico, Virgin Islands, America Samoa and the Commonwealth of the Northern Marianas. [1]

After compiling all of the data sets, I chose multiple factors within the data sets to analyze between Non-Hispanic white and Non-Hispanic blacks. Birth certificates in the United States report race and Hispanic origin independently, therefore the majority of the tables in the NVSS datasets report non-Hispanic white, non-Hispanic black, and Hispanic. [2] The table below

[1]These areas are not included in the birth totals

[2] In 2003 there was a revision of the U.S. Standard Certificate of Live Birth which allowed for the reporting of more than one race

represents a sample data table from the NVSS.

**Table 5. Births and birth rates, by Hispanic origin of mother, and by race for mothers of non-Hispanic origin: United States, 1989–2012**

[Birth rates are births per 1,000 population in specified group. Fertility rates are births per 1,000 women aged 15–44 in specified group. Populations estimated as of April 1 for census years and estimated as of July 1 for all other years. Populations for specified Hispanic groups based on American Community Survey estimates as of July 1 for 2010–2012; prior to 2010, populations for specified Hispanic groups based on Current Population Survey estimates as of April 1 for census years and estimated as of July 1 for all other years]

| | | Hispanic | | | | | | Non-Hispanic | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Measure and year | All origins[1] | Total | Mexican | Puerto Rican | Cuban | Central and South American | Other and unknown Hispanic | Total[2] | White | Black |
| Number | | | | | | | | | | |
| 2012 | 3,952,841 | 907,677 | 555,823 | 67,182 | 17,396 | 131,794 | 135,482 | 3,014,314 | 2,134,044 | 583,489 |
| 2011 | 3,953,590 | 918,129 | 566,699 | 67,018 | 17,131 | 136,221 | 131,060 | 3,008,200 | 2,146,566 | 582,345 |
| 2010 | 3,999,386 | 945,180 | 598,317 | 66,368 | 16,882 | 142,692 | 120,921 | 3,026,614 | 2,162,406 | 589,808 |
| 2009 | 4,130,665 | 999,548 | 645,297 | 68,486 | 16,641 | 148,647 | 120,477 | 3,101,330 | 2,212,552 | 609,584 |
| 2008 | 4,247,694 | 1,041,239 | 684,883 | 69,015 | 16,718 | 155,578 | 115,045 | 3,173,629 | 2,267,817 | 623,029 |
| 2007 | 4,316,233 | 1,062,779 | 722,055 | 68,488 | 16,981 | 169,851 | 85,404 | 3,222,460 | 2,310,333 | 627,191 |
| 2006 | 4,265,555 | 1,039,077 | 718,146 | 66,932 | 16,936 | 165,321 | 71,742 | 3,196,082 | 2,308,640 | 617,247 |
| 2005 | 4,138,349 | 985,505 | 693,197 | 63,340 | 16,064 | 151,201 | 61,703 | 3,123,005 | 2,279,768 | 583,759 |
| 2004 | 4,112,052 | 946,349 | 677,621 | 61,221 | 14,943 | 143,520 | 49,044 | 3,133,125 | 2,296,683 | 578,772 |
| 2003 | 4,089,950 | 912,329 | 654,504 | 58,400 | 14,867 | 135,586 | 48,972 | 3,149,034 | 2,321,904 | 576,033 |
| 2002 | 4,021,726 | 876,642 | 627,505 | 57,465 | 14,232 | 125,981 | 51,459 | 3,119,944 | 2,298,156 | 578,335 |
| 2001 | 4,025,933 | 851,851 | 611,000 | 57,568 | 14,017 | 121,365 | 47,901 | 3,149,572 | 2,326,578 | 589,917 |
| 2000 | 4,058,814 | 815,868 | 581,915 | 58,124 | 13,429 | 113,344 | 49,056 | 3,199,994 | 2,362,968 | 604,346 |
| 1999 | 3,959,417 | 764,339 | 540,674 | 57,138 | 13,088 | 103,307 | 50,132 | 3,147,580 | 2,346,450 | 588,981 |
| 1998 | 3,941,553 | 734,661 | 516,011 | 57,349 | 13,226 | 98,226 | 49,849 | 3,158,975 | 2,361,462 | 593,127 |
| 1997 | 3,880,894 | 709,767 | 499,024 | 55,450 | 12,887 | 97,405 | 45,001 | 3,115,174 | 2,333,363 | 581,431 |
| 1996 | 3,891,494 | 701,339 | 489,666 | 54,863 | 12,613 | 97,888 | 46,309 | 3,133,484 | 2,358,989 | 578,099 |
| 1995 | 3,899,589 | 679,768 | 469,615 | 54,824 | 12,473 | 94,996 | 47,860 | 3,160,495 | 2,382,638 | 587,781 |
| 1994 | 3,952,767 | 665,026 | 454,536 | 57,240 | 11,889 | 93,485 | 47,876 | 3,245,115 | 2,438,855 | 619,198 |
| 1993 | 4,000,240 | 654,418 | 443,733 | 58,102 | 11,916 | 92,371 | 48,296 | 3,295,345 | 2,472,031 | 641,273 |
| 1992[3] | 4,049,024 | 643,271 | 432,047 | 59,569 | 11,472 | 89,031 | 51,152 | 3,365,862 | 2,527,207 | 657,450 |
| 1991[3] | 4,094,566 | 623,085 | 411,233 | 59,833 | 11,058 | 86,908 | 54,053 | 3,434,464 | 2,589,878 | 666,758 |
| 1990[4] | 4,092,994 | 595,073 | 385,640 | 58,807 | 11,311 | 83,008 | 56,307 | 3,457,417 | 2,626,500 | 661,701 |
| 1989[5] | 3,903,012 | 532,249 | 327,233 | 56,229 | 10,842 | 72,443 | 65,502 | 3,297,493 | 2,526,367 | 611,269 |
| Birth rate | | | | | | | | | | |
| 2012[6] | 12.6 | 17.1 | 16.3 | 13.5 | 8.9 | 22.3 | (8) | 11.7 | 10.7 | 14.6 |
| 2011[6] | 12.7 | 17.6 | 16.9 | 13.7 | 9.1 | 23.0 | (8) | 11.7 | 10.8 | 14.7 |
| 2010[6] | 13.0 | 18.7 | 18.2 | 14.1 | 9.0 | 23.4 | (8) | 11.8 | 10.9 | 15.1 |
| 2009[6] | 13.5 | 20.3 | 19.8 | 15.5 | 9.5 | 25.5 | (8) | 12.2 | 11.2 | 15.7 |
| 2008[6] | 14.0 | 21.8 | 21.7 | 16.4 | 10.1 | 26.1 | (8) | 12.5 | 11.5 | 16.3 |
| 2007[6] | 14.3 | 23.0 | 23.9 | 17.1 | 10.2 | 24.6 | (8) | 12.8 | 11.7 | 16.6 |
| 2006[6] | 14.3 | 23.3 | 24.6 | 17.5 | 10.4 | 23.8 | (8) | 12.7 | 11.7 | 16.5 |
| 2005[6] | 14.0 | 22.9 | 24.5 | 17.0 | 10.2 | 22.7 | (8) | 12.5 | 11.6 | 15.8 |
| 2004[6] | 14.0 | 22.8 | 24.8 | 16.0 | 9.3 | 22.1 | (8) | 12.6 | 11.7 | 15.8 |
| 2003[6] | 14.1 | 22.8 | 24.6 | 15.0 | 10.0 | 23.0 | (8) | 12.7 | 11.8 | 15.9 |
| 2002[6] | 14.0 | 22.7 | 24.3 | 16.5 | 10.1 | 22.5 | (8) | 12.6 | 11.7 | 16.1 |

For each year for which I have a data set (2002-2012) I analyzed the total births, maternal educational attainment, number of prenatal care visits, rates of preterm birth, rates of low birthweight, and rates of very low birthweight for non-Hispanic white women, and non-Hispanic Black women.

Following the calculation of the aforementioned rates, I conduced a statistical t-test for each of the measures. A t-test tests two independent means against one another to determine if a significant relationship between the two means exists.

I conducted five t-tests (Maternal education, prenatal care, preterm birth, low birthweight, and very low birthweight). The purpose of conducting these statistical tests was to compare the averages between the two racial groups to determine if statistical significance exists. Averages for each measure are placed into separate treatment groups and then tested against one another to calculate statistical significance. Statistical significance from a t-test is determined through the calculation of a "p-value". A p-value is considered significant if it is $<0.05$. For each measure, I have included a p-value calculated by the t-test as well as copies of the test and treatment groups.

## Measures

*Race*

Women are asked to self-identify their race on the birth certificate. Race options on the birth certificate are; White, Black, American Indian or Alaska Native, and Asian or Pacific Islander.

Hispanic origin and race are reported separately on the birth certificate. Since 1993, the race and Hispanic origin of the father has also been included. This study examines the comparison of measures between non-Hispanic white mothers and non-Hispanic Black mothers. Data for non-Hispanic whites and non-Hispanic Blacks are available for all measures used in this study including educational attainment of the mother, and prenatal care.

*Total Births*

Total births are compiled by the NVSS in aggregate form, listing the overall total number of live births in each given year beginning January 1, and ending with December 31st from birth certificate data. Within the total birth data set, births are delineated between races of mother, and live birth order (number of children born alive to the mother). Further, these data

are separated by the age of the mother in years. For this measure I only examined the total number of births between white and Black mothers. Age and birth order was not a factor in this study.

*Maternal Education*

The level of educational attainment for mothers has continuously been associated with positive birth outcomes as previously outlined in the literature review. The aim of this study was to investigate if a significant relationship between educational attainment of the races exits. By eliminating a confounding factor such as education from the data set, a correlation between adverse birth outcomes and race can be interpreted.

Maternal education data is available in the NVSS data sets from 2002-2010. Beginning with 2011 there was a revision to the natality public-use data file, which excluded several key noncomparable items from public-use.[3]

Education is noted by race, and age of mother. Respondents are given the options of; 8th grade or less, 9th through 12th grade with no diploma, high school graduate or GED completed, some college credit, but no degree, Associate degree (AA, AS), Bachelor's degree (BA, AB, BS), Master's degree (MA, MS, MEng), Doctorate (PhD, EdD), and Professional Degree (MD, DDS, DVM, LLB, JD).

For this study I compared the adverse birth outcome rates for mothers who have completed high school and above. The purpose of using only mothers with higher educational

[3] Including; infertility therapies, WIC food, source of payment for the delivery, maternal morbidity, and breastfeeding

attainment is to disperse the myth that low educational attainment by Black mothers results in their higher rates of preterm birth, low birthweight, and very low birthweight.

*Prenatal Care*

The number of prenatal care visits a mother has received has also historically played a role in adverse birth outcomes for both white and Black mothers. Prenatal care is defined as: "visits to a health care provider which include a physical exam, weight checks, and blood and urine tests" (Eunice Kennedy Shriver National Institute of Child Health and Human Development).

Similar to the statistics on maternal education, data is unavailable for public use regarding prenatal care visits from 2011- present. Prenatal care statistics from 2002-2010 are available via data subsets from the NVSS.

Respondents are given an option on the birth certificate form of when they began prenatal care, and how many prenatal care visits they attended. For this study I examined the total number of prenatal care visits by the race of the mother. Options for the number of visits are; no visits, 1-2, 3-4, 5-6, 7-8, 9-10, 11-12, 13-14, 15-16, 17-18, 19 or more, and not stated.

It is recommended that women attend a minimum of 3-4 prenatal care visits (Mayo Clinic), therefore this study compared the number of prenatal visits of 3 or more between non-Hispanic white mothers and non-Hispanic black mothers.

*Preterm Birth*

Preterm birth is defined by the NVSS as the birth of an infant before 37 weeks. Preterm birth is indicative of future health problems in infants, and often examined as a definitive factor for a healthy or unhealthy pregnancy.

The NVSS measures gestational age as completed weeks of gestation. This study compared preterm birth rates per 1,000 live births between non-Hispanic white mothers and non-Hispanic Black mothers from 28-36 completed weeks of gestation.

*Low birthweight (LBW) and Very low birthweight (VLBW)*

The NVSS defines low birthweight as infants weighing less than 2500 grams. Very low birthweight infants are defined as infants weighting less than 1500 grams. Nationally, the rate of low birthweight and very low birthweight infants has been steadily declining (CDC) but a disparity among the races still exists. Very low birthweight and low birthweight infants can exhibit signs of slower physical and mental development, and are at higher risks for infant mortality (Fanaroff et al 2007).

Birthweight is measured by the NVSS in 500-gram intervals. Respondents are given the option of; less than 500, 500-999, 1000-1499, 1500-1999, 2000-2499, 2500-2999, 3000-3499, 3500-3999, 4000-4999, 4500-4999, and 5,000 or more.

This study compared the rate of births that resulted in low birthweights between non-Hispanic whites and non-Hispanic Blacks through the range of 1500 grams – 2499 grams. Very low birthweight was compared between the rate of births that resulted in infants weighing less than 500-1499 grams.

## Results

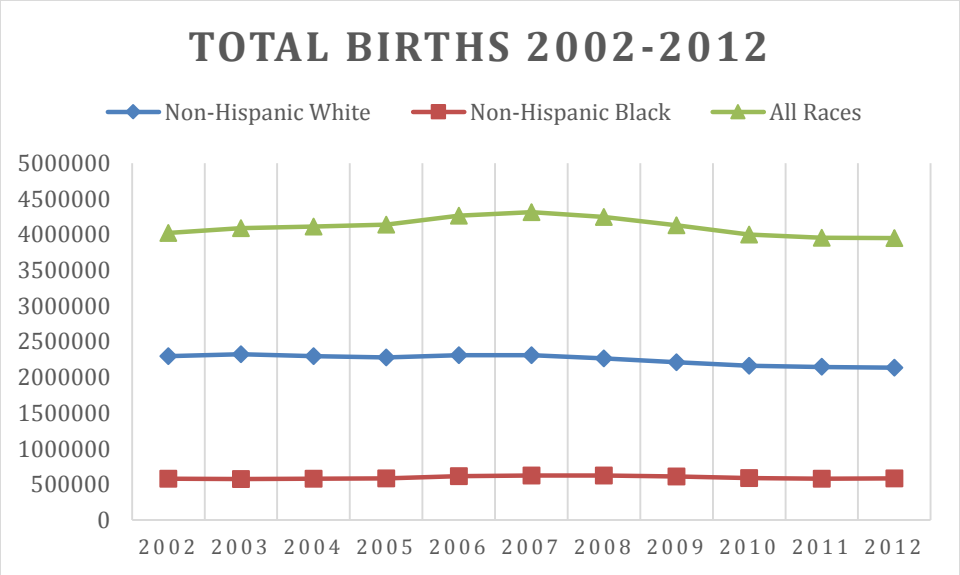
In this chapter I will describe the results from the data analysis I completed. My results are separated into six sections, delineated for each adverse birth outcome I analyzed. I have included a graph of the statistics with each measure to further illustrate the gap in birth outcomes between Non-Hispanic white mothers and Non-Hispanic Black mothers. I have also included screenshots of the statistical t-tests I performed.

### *Data Analysis Methods*

To analyze my data, I collected aggregate data from the six variables I wished to study; total births, maternal education, preterm birth, prenatal care visits, low birthweight, and very low birthweight. I took aggregate data for each of these variables from the years 2002-2012 for non-Hispanic Black mothers and non-Hispanic white mothers. I then calculated the occurrence rate for each variable for each year and race. Finally, I compiled all of the rates in line graphs spanning the time range 2002-2012. I delineated the different races in the graphs by using different symbols. By using line graphs it is easier to showcase a trend spanning 2002-2012, and the widening gap between adverse birth outcomes and the races.

Following the analysis of the rates for each measure, I conducted to statistical t-test to further showcase the significance of the disparity for each outcome.

### *Section 1- Total Number of Births*



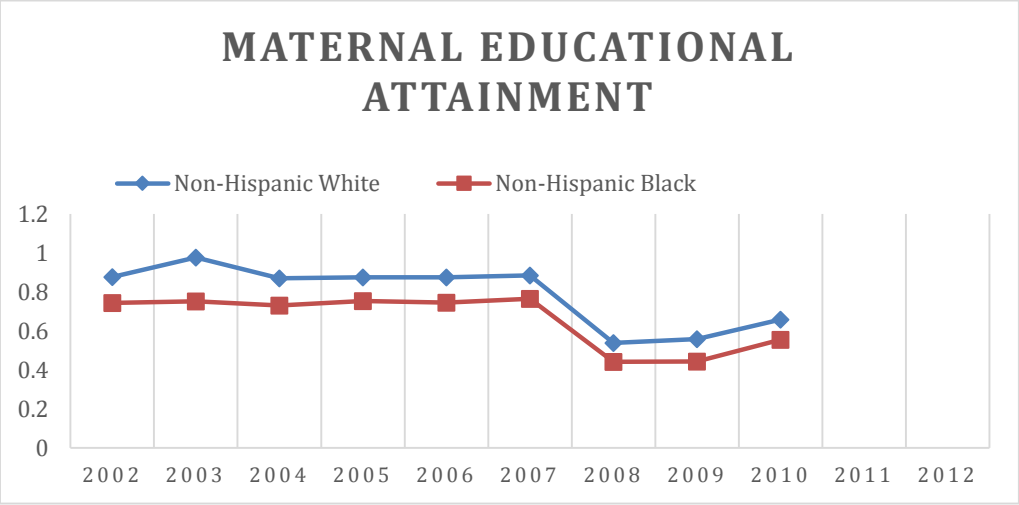

**Graph 1**

In Graph 1, the top diamond line represents all births regardless of race. The middle diamond line represents all total births in the United States from non-Hispanic white mothers. The bottom square line represents all total births in the United States by individuals who identified themselves as Non-Hispanic Black.

When examining the various adverse birth outcomes between Non-Hispanic white mothers, and Non-Hispanic Black mothers it is important to note the large difference in the total number of births these racial categories experience each year. As Graph 1 illustrates, the number of births for both Non-Hispanic whites, and Non-Hispanic Blacks stay relatively stagnant, with an approximate 150,000 birth difference between them. There have been slight fluctuations in the total number of births throughout the ten year period I analyzed. All three categories represented in Graph 1 have seen similar birth totals from 2002-2012. 2007 saw the largest number of total births with 4,316,233. 2012 has the lowest number of total births with 3,952,841. This is representative of the overall trend of declining total births in the United States. The

declining birth trend can be seen in both racial groups as well. The decline in birth rates across races is a result of delayed childbirth, as well as the increase in birth control options for women (Last 2013).

*Section 2- Maternal Education*




**Graph 2**

Maternal education has historically been considered a factor for improving adverse birth outcomes. In examining maternal education rates for Non-Hispanic white mothers, and Non-Hispanic black mothers from 2002-2012 I found little difference between the two groups.

Graph 2 represents both Non-Hispanic white and Non-Hispanic black mothers who received a high-school diploma or GED equivalent, or higher, with the highest level of attainment being a PhD or other professional degree (MD, JD, DDS). Although the Non-Hispanic white rate is consistently higher each year, the gap between the two groups is not significant.

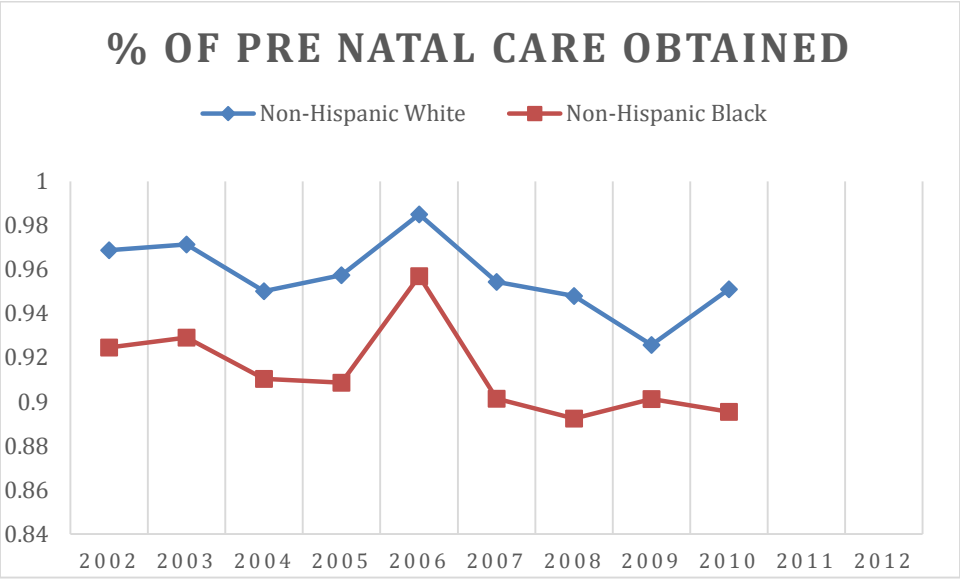
The most important illustration in this graph, is the sharp decline in education rates beginning with 2008. The 2007 education rates for the two groups were 95%, and 90%, respectively. However, in 2008 these rates drastically dropped to 54% and 44%, respectively. The sharp drop in rates is due to a change in the reporting statistics used by NVSS. NVSS no longer required educational attainment as a required section on the United States birth certificate. As a result, the overall numbers are lower. When examining the figures post -2007 it is thus important to examine the lack of a large gap between the two races, and not the rates themselves. The below 50% education rate is not indicative of an overall trend, as teenage births in the United States have been decreasing, and first child births to older women have been increasing (NVSS).

The t-test for maternal education, resulted in a p-value of 0.08163186. The full analysis of the t test is: $t(9) = 1.858243$, p 0.08163186. This p value is **not significant,** therefore there is not a significant difference in the level of educational attainment between the two races. Because of this, the adverse birth outcomes that Black women experience at higher rates than white women can not be attributed to their lack of education.

Further, these educational attainment figures were no longer included in the Final Birth Data Set released by the NVSS each year. These figures are only available by accessing the data service “Beyond 20/20”, a subset of the NVSS. It is interesting that the NVSS and CDC do not

find these numbers as valuable, or statistically significant considering the long history the CDC has with suggesting a strong correlation between birth outcomes and education. Also important to note, is the educational attainment level of fathers is not recorded in any capacity. Other factors of fathers are recorded such as race, and drug and alcohol use but not education.

*Section 3- Prenatal Care*




**Graph 3**

Prenatal Care is also considered a strong indicator of adverse birth outcomes by health professionals and governmental agencies. All mothers are urged to seek prenatal care beginning with their first trimester, and continuing until they give birth to reduce the risk of preterm birth, low birthweight, and very low birthweight.

Graph 3 represents Non-Hispanic white and Non-Hispanic black mothers who utilized prenatal care services, with three or more visits. Although the Non-Hispanic black rate is lower each year than the Non-Hispanic white rate, the rate for Non-Hispanic black mothers never drops below 88%. Therefore, it is unlikely that a correlation can be made between Non-Hispanic black

mothers not utilizing prenatal care and their subsequent adverse birth outcomes. Because their numbers are so similar to those of Non-Hispanic white mothers, it is important to utilize a statistical test to determine if there is significance between the two rates.

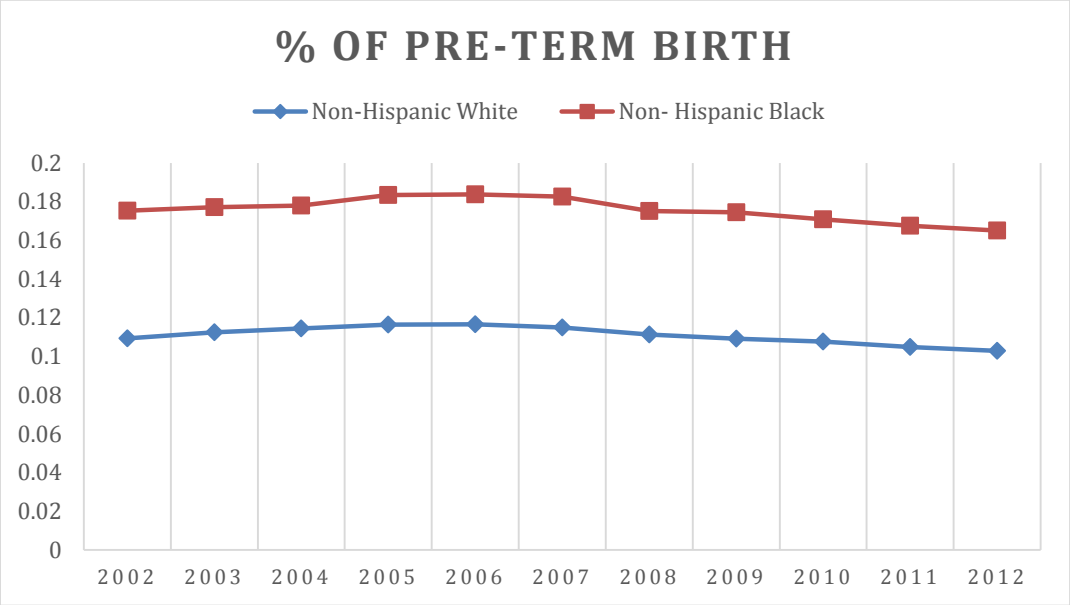
The t-test for prenatal care, resulted in a p-value of 0.00015265. The full analysis is: t(9) = 4.923822, p 0.00015265. This p value is **significant,** therefore there is a significance in the rate of prenatal care visits between the races. More research should be conducted to fully understand the relationship between prenatal care and race. It is important to note that the prenatal care rate for non-Hispanic Black women does not drop below 88%, therefore it is not a large difference.

Although not represented in Graph 3 or this project, the NVSS also includes figures for when mothers began receiving prenatal care (NVSS), beginning with the first trimester. The majority of both racial groups began care in the first trimester, which is in accordance with CDC guidelines on proper prenatal care (CDC).

Similar to the figures from maternal educational attainment, prenatal care no longer became a require field for mothers to fill out when completing birth certificates. Therefore there is a visible decrease in the overall percentages for both racial groups. The NVSS and CDC do not qualify their decision to stop requiring these indicators, but it would be benefical to examine if the reporting agencies themselves found a lack of correlation between educational attainment, prenatal care, and adverse birth outcomes.

*Section 4 – Pre-Term Birth*

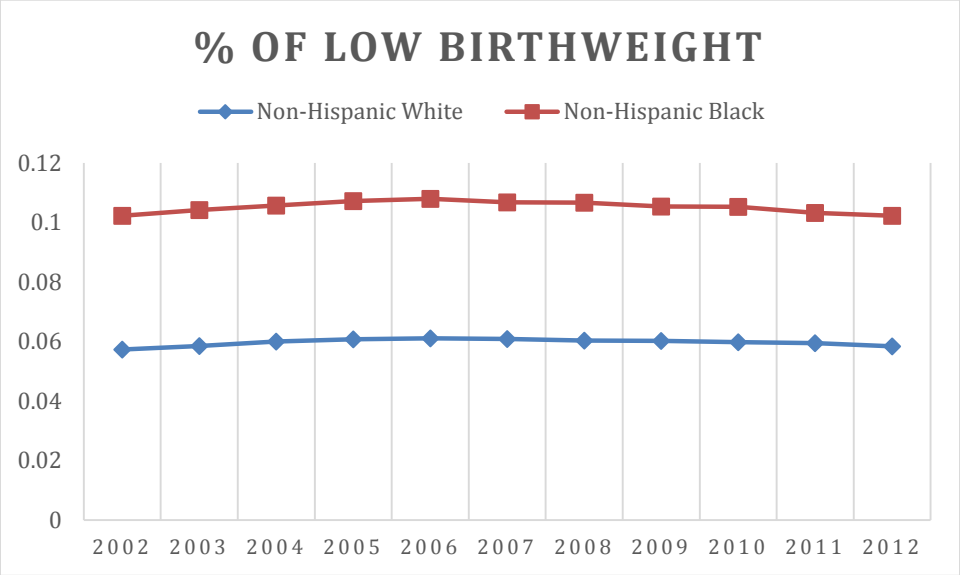
Preterm birth is defined as the birth of an infant before 37 weeks (CDC). There is a widening gap in the outcome of preterm birth between non-Hispanic Black mothers and non-Hispanic white mothers. The graph below indicates the differences between Black women and white women from 2002-2012.




**Graph 4**

The t-Test for preterm birth, resulted in a p-value of <0.00001. The full analysis is t(11) = 27.824197, p <0.00001. This p value is **significant,** therefore there is a statistical significance in the difference between the rates of preterm birth that Black women experience and white women experience. Expounding upon the previous t-tests run, the higher rate in preterm birth can not be attributed to lack of maternal education. Preterm birth is a significant indicator for infant mortality, and this gap needs to be further researched by public health professionals.

*Section 5 – Low Birthweight (LBW)*




**Graph 5**

Low birthweight is defined as the birth of an infant between 1500-2499 grams, or roughly 3-6 lbs. Low birthweight is often used as an indicator for infant mortality, and can also be an indicator for lifelong problems in infants as well (CDC Tracking Network).

Graphs 5 and 6 represents the overall trend of the birthweight disparity that exists between Non-Hispanic white infants, and Non-Hispanic black infants. From 2002-2012 Non-Hispanic black mothers are experiencing higher rates of low and very low birthweight.

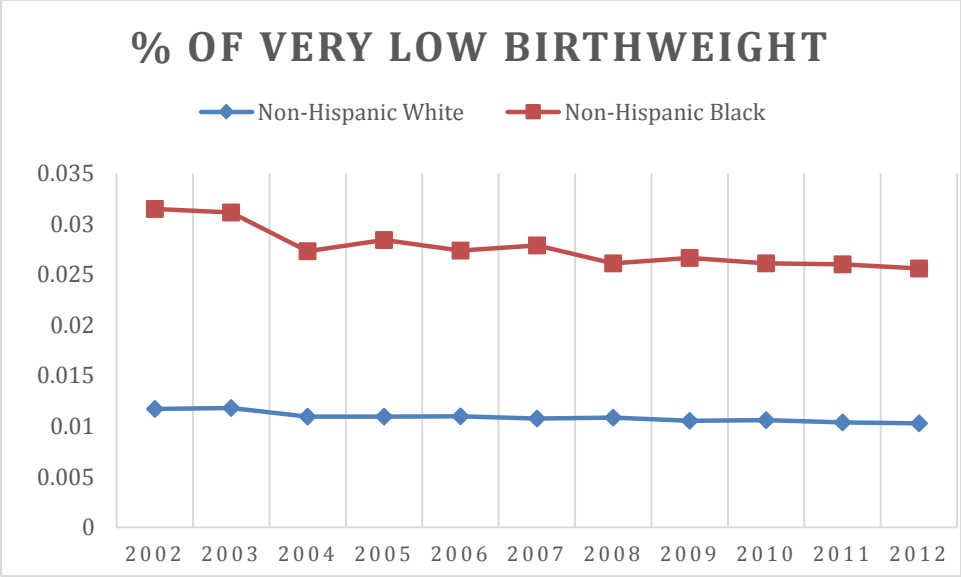
What is most important to note in this graph is not only the disparity that exists, but the stagnation that is illustrated in the Non-Hispanic black racial group. In recent years, the Non-Hispanic white racial group has seen a decrease in low birthweight. However, in the Non-Hispanic black group there has been no decrease. The percentage for low birthweight in Non-

Hispanic black infants has remained at 10%, while the percentage for Non-Hispanic white infants has decreased from 5%.

The t-Test for low birthweight, resulted in a p-value of <.00001. The full analysis is: t(11) = 65.292371, p <0.00001. This p value is **significant,** therefore there is a statistical significance in the difference between the rates of low birthweight that Black women experience and white women experience. Similar to preterm birth, this is important as it is a clear indicator of infant mortality and should be studied.

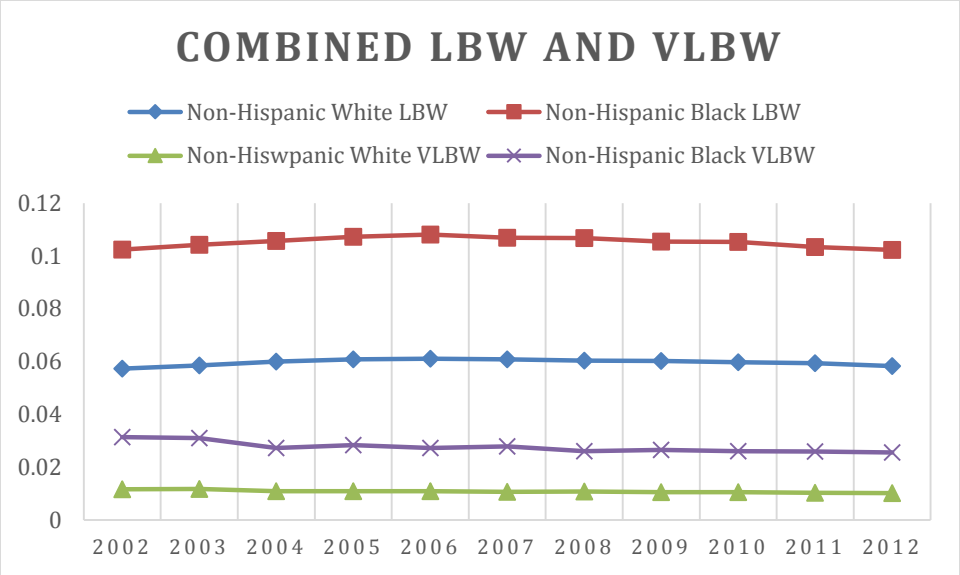
Scientific and epidemiological studies need to recognize the need for racism to be used as a viable scientific variable, in order for this gap to be more fully explored. Several successful studies, such as the Giscombe and Lobel study outlined in the literature review, have used racism as a variable by measuring corticotrophin levels and questionnaires. The need for this variable is further represented in the trend of very low birthweight.

*Section 6 – Very Low Birthweight (VLBW)*




**Graph 6**

Very Low Birthweight is another indicator for infant mortality, and has been linked to several other childhood and adult medical problems (Were and Bwibo 2009). Graph 6 represents a difference between the racial groups in this category as well. Similar to the rates of low birthweights, there is stagnation between the groups which overall represents the need for a public health intervention as well.




**Graph 7**

Graph 7 illustrates both races and the corresponding low birthweight and very low birthweight rates. This graph represents the disparity that exists in both variables. These rates show an increase in the non-Hispanic Black low birthweight categories.

The t-test for very low birthweight, resulted in a p-value of <0.00001. The full analysis is: $t(11) = 26.914958$, $p < 0.00001$. This p value is **significant**. Similar to the disparity that exists between low birthweight and Black and white women, further research needs to be conducted to improve this gap.

## Discussion

In this section I will outline how race can be incorporated into further public health and clinical studies. By using race as a quantifiable variable, more insight will be gained into the effects of racial stress and discrimination and the resulting health outcomes and gaps.

### *Study Results*

Following the statistical analysis of maternal education, prenatal care, preterm birth, low birthweight, and very low birthweight I was surprised at the statistical significance of prenatal care visits between the races. However, I think what is most important to recognize following this analysis is the lack of statistical significance between educational attainment. As current research is focused on improving prenatal and educational attainment by Black women to improve birth outcomes, the lack of statistical significance between 2002-2012 suggests a need for change in how health professionals view the health gap. Additionally, the statistical significance for low birthweight and very low birthweight, suggest further research surrounding the role of internalized racism needs to be conducted to fully understand why a gap exists between the races.

### *Findings and Prior Literature*

These findings expound upon knowledge from Lobel et al, as well as Collins et al, as outlined in the literature review. Black women are experiencing disproportionately higher rates of adverse birth outcomes than white women. When examining these rates in tandem with their high levels of education as well as high levels of prenatal care visits, these rates become more concerning. More epidemiological and public health studies need to be conducted to understand the gap due to racial stress. My research refutes the public health ideology that prenatal care and high levels of education are "safeguards" against adverse birth outcomes. My research has recognized a gap in literature that fails to understand the health gap outside of theories regarding social determinants of health. In order for the health gap between the races to truly close, a broader understanding of "scientific" and study parameters needs to be implemented. As indicated by Lobel and Collins, there are certainly ways in which to conduct studies that offer options for indicating racial stress while still maintaining an epidemiological core.

*Study Limitations*

The most glaring limitation of this project was the lack of continual consistent data from the NVSS. As outlined previously, there were several changes made to reporting requirements for mothers on birth certificates. As such, some data (such as maternal education) was not collected for certain years. Another limitation is all of the data analyzed was self-reported. Therefore the accuracy of these rates is uncertain. Another limitation of this study was the lack of existing research on the links between racial stress and adverse birth outcomes. As I personally did not conduct a study questioning women on their perceived racial stress and subsequent adverse birth outcomes, I can only hypothesize the link that could exist between perceived racial stress and adverse birth outcomes.

*Adverse Birth Outcomes and Black Women*

Preceding data on racial stress and discrimination regarding adverse birth outcomes and Black women, theories regarding the widening gap of outcomes for Black and white women were the result of individual grounded ideologies. Public Health interventions and studies focused on determinants of health such as; socioeconomic status, geographic location, and educational attainment. Although there is indeed a correlation between these factors and adverse birth outcomes, they do not provide the entire picture for public health professionals seeking to understand the *widening* health gap between Black and white women.

Feminist science thus becomes integral in providing the "missing link" between race and birth outcomes. Feminist scientists recognize that not only is it difficult for women to change social determinants of health such as socioeconomic status and geographic location, but that in imploring women to do so a system of implementing fault on the mother is grounded. Feminist science can provide an alternative, such as examining racial discrimination as a factor in adverse birth outcomes. By recognizing the inherent racial bias women of color undergo daily, and the heightened racial bias attributed to pregnant women of color, feminist science can help navigate the often patriarchal medical system.

An option for implementing feminist science in public health practice is creating a questionnaire used for perceived racial bias by Black women throughout their lifespan up until their pregnancy. It is important to include racial bias before their pregnancy as the allostatic load of stress from racial bias causes adverse birth outcomes.

*Intervention*

Beginning my research I was hoping to discover a viable intervention to help improve Black women's adverse birth outcomes. However, as racism seems to be at the root of the health gap for Black and white women, I am not sure a public health intervention is possible. Public health can intervene insofar as changing the discourse surrounding Black women and infant mortality. Many of the PR materials that encourage safe practices with infants are targeted in low-income neighborhoods and lecture on pre-natal care. For example, Hamilton County is host to a 17.8 infant death rate per 1,000 live births to black mothers (Cradle Cincinnati). This rate is significantly higher than the national average of 12.8 and has resulted in the creation of numerous organizations devoted to improving infant mortality, specifically Black infant mortality in Hamilton County.

Below is a photo from the Cincinnati Health Department advertising "A Healthy Pregnancy Means a Healthy Baby". Both the mother and the infant are perceived to be of African-American descent. This piece of PR material represents the ideology that a healthy pregnancy will safeguard mothers from adverse birth outcomes an infant mortality. A more effective intervention would be ways in which to deal with perceived racial stress. However, as the basis for many previous studies rely on data that it is a buildup of this racial stress, the point of pregnancy may be too late to pose an intervention.


*Final Thoughts*

Throughout this project I was saddened to see the lack of resources that exist for Black women who seek to understand *why* their health outcomes are disparate. It is my hope that in the future for public health more studies begin to incorporate racial bias as a tool for measuring the health gap.

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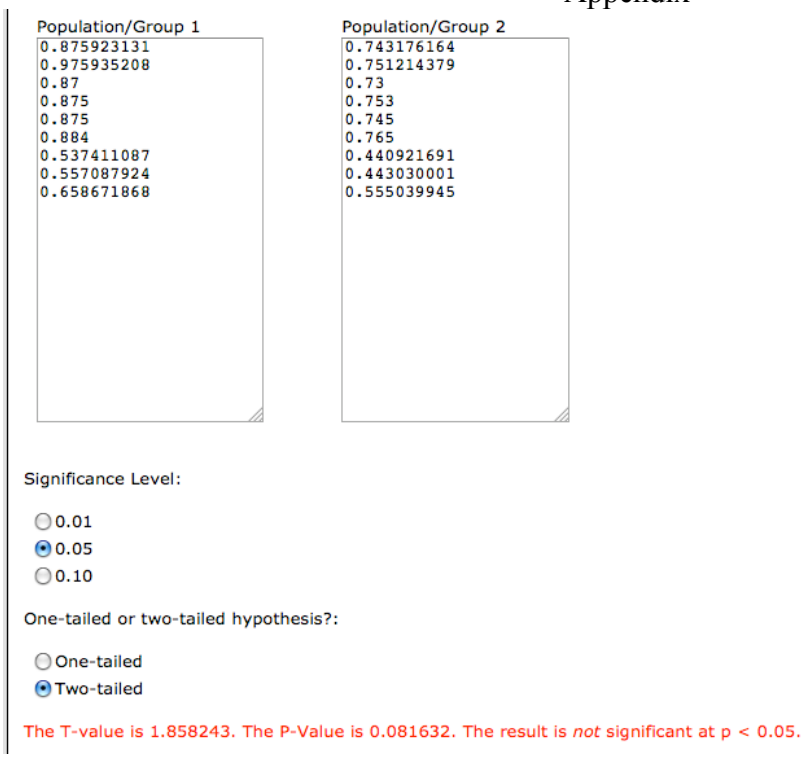
# Appendix



Population/Group 1

0.875923131
0.975935208
0.87
0.875
0.875
0.884
0.537411087
0.557087924
0.658671868

Population/Group 2

0.743176164
0.751214379
0.73
0.753
0.745
0.765
0.440921691
0.443030001
0.555039945

Significance Level:

- 0.01
- (•) 0.05
- 0.10

One-tailed or two-tailed hypothesis?:

- One-tailed
- (•) Two-tailed

The T-value is 1.858243. The P-Value is 0.081632. The result is *not* significant at $p < 0.05$.

Maternal Education T-Test

| Population/Group 1 | Population/Group 2 |
|---|---|
| 0.96872362 | 0.924586961 |
| 0.971435017 | 0.929137326 |
| 0.950194978 | 0.910411736 |
| 0.957485148 | 0.908648946 |
| 0.984989431 | 0.956960504 |
| 0.95433905 | 0.901414402 |
| 0.948049927 | 0.892367771 |
| 0.925788863 | 0.901212958 |
| 0.951063306 | 0.895491414 |

Significance Level:

- ○ 0.01
- ◉ 0.05
- ○ 0.10

One-tailed or two-tailed hypothesis?:

- ○ One-tailed
- ◉ Two-tailed

The T-value is 4.923822. The P-Value is 0.000153. The result is significant at $p < 0.05$.

Prenatal Care T-Test

| Population/Group 1 | Population/Group 2 |
|---|---|
| 0.109275436 | 0.175370676 |
| 0.112384922 | 0.177045412 |
| 0.114357532 | 0.17790598 |
| 0.116444305 | 0.183395888 |
| 0.116631004 | 0.183782181 |
| 0.114892528 | 0.182606256 |
| 0.111268629 | 0.17515236 |
| 0.109060036 | 0.174407465 |
| 0.107606065 | 0.170897987 |
| 0.104888459 | 0.167500365 |
| 0.102835743 | 0.164998826 |

Significance Level:

- ○ 0.01
- ◉ 0.05
- ○ 0.10

One-tailed or two-tailed hypothesis?:

- ○ One-tailed
- ◉ Two-tailed

The T-value is 27.824197. The P-Value is < 0.00001. The result is significant at p < 0.05.

Preterm Birth T-Test

Population/Group 1

```
0.057303334
0.058539027
0.059974755
0.06080531
0.061109138
0.060824565
0.060374774
0.06023768
0.059740863
0.059437259
0.058348375
```

Population/Group 2

```
0.102331694
0.104202363
0.10571866
0.107254634
0.108028067
0.106827107
0.106739815
0.105419434
0.105285999
0.103301308
0.102236717
```

Significance Level:

- ○ 0.01
- ◉ 0.05
- ○ 0.10

One-tailed or two-tailed hypothesis?:

- ○ One-tailed
- ◉ Two-tailed

The T-value is 65.292371. The P-Value is < 0.00001. The result is significant at p < 0.05.

Low birthweight T-Test

Population/Group 1

0.011705037
0.011804536
0.010939255
0.010958133
0.01097486
0.010747801
0.01086113
0.010547102
0.010611328
0.010375176
0.010271464

Population/Group 2

0.031459275
0.031114537
0.027304362
0.028414123
0.027345617
0.02787827
0.026095093
0.026619793
0.026106801
0.025996617
0.025596027

Significance Level:

- 0.01
- (•) 0.05
- 0.10

One-tailed or two-tailed hypothesis?:

- One-tailed
- (•) Two-tailed

The T-value is 26.914958. The P-Value is < 0.00001. The result is significant at p < 0.05.

Very low birthweight T-Test